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20 January 1984

MEMORANDUM FOR THE RECORD

SUBJECT: The Role of Western Oil and Gas Equipment in Soviet Energy Development

1. Subject paper was prepared at the request of the NIO/Economics. The paper examines, at the Secret level without dissemination controls, the extent of Soviet dependence on Western equipment and technology for exploitation of oil and natural gas resources, Soviet efforts to improve the supply of indigenous equipment, and the outlook for continued purchasing from the West. It should be of interest to a wide variety of audiences interested in issued of technology transfer, Soviet energy problems, and Soviet dependences on the West.

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[redacted]

Chief, Resources Branch
Soviet Economy Division
Office of Soviet Analysis

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SOVM 84-10009

[redacted]

SECRET

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The Role of Western Oil And Gas Equipment in Soviet Energy Development

SOVM 84-10009

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I. Overview

The USSR depends upon the West for selected high-quality and advanced state-of-the-art oil and gas equipment, but the sporadic unavailability of Western equipment has not prevented the Soviet Union from becoming the world's leading producer of oil and natural gas. In recent years the Soviets have undertaken a program to enhance domestic equipment manufacturing capability, and this effort will continue throughout the decade and into the 1990s. But thus far, the inefficiencies of the Soviet economic system have hindered both the production of high-quality petroleum equipment and the efficient use of advanced techniques and equipment. [redacted] 25X1

During the 1970s the USSR purchased some $5 billion worth of Western oil and gas equipment to cover shortages in its own supplies or for particularly difficult applications. These imports were only a small share of total Soviet oil and gas equipment requirements, but their potential impact is significant as they were slated for the Soviets' largest and most critical projects. Among the most important of these acquisitions were a turn-key plant to produce high-quality drill bits; gas-lift equipment for two major oilfields in West Siberia; an assembly yard for producing offshore drilling platforms; large-diameter linepipe, pipelayers, and turbine-compressors for the gas-pipeline network; and equipment and chemical plants for enhanced-oil-recovery projects. [redacted] 25X1

During the remainder of the 1980s the cost and speed of

Soviet energy development will depend partly on the level of imports of Western oil and gas equipment and know-how. Although Soviet dependence on imports of Western pipe and compressors for gas pipelines should decline, dependence on imports of Western oil equipment will increase as exploration and development shift to deeper and more complex onshore and offshore deposits. [redacted] 25X1

II. Introduction

Soviet oil production during 1961-80 rose at an average annual rate of 7 percent, but it appears to be reaching a plateau: output grew only about 0.8 percent per year in 1982-83. During the last two decades, however, Soviet production of natural gas rose dramatically at an average annual rate of 11.8 percent during 1961-83, and prospects are good for large annual increases to continue through the 1980s. 25X1

The USSR produces most of its own petroleum equipment, but domestic manufacturers have been unable to meet the rising demand of the oil and gas industries for more and better equipment. The lack of adequate amounts of high-quality equipment has hampered efforts in several areas of the petroleum industry, including drilling and production in West Siberia and the enhanced oil recovery program. 25X1

In the late 1970s the Soviets showed increasing awareness of the difficult problems confronting their oil industry--rapidly rising drilling requirements, increasing need for fluid-lift equipment, and a decline in the quality of oil from new fields. Efforts were undertaken to expand and improve domestic production capabilities based on indigenous and imported technology, as well as to import a wide variety of equipment to support the oil and gas development programs.* 25X1

This paper examines the importance of technology transfer

*Soviet statistics on total oil production include both crude oil and gas condensate. The Gas Ministry is responsible for all offshore production--oil as well as gas. Gas Ministry oil output thus includes offshore oil output, as well as gas condensate produced at gas fields.

from the West to the Soviet oil and gas industries in the 1970s and early 1980s. The implications for development later in the 1980s are discussed against the backdrop of likely Soviet progress in domestic technology and manufacturing capability.

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III. Availability and Adequacy of Domestic Equipment

The USSR is one of the world's major producers of petroleum equipment. However, during the 1976-80 period, despite a substantial increase in output of oil equipment--reportedly by 60 percent over that in 1971-75--domestic supply was adequate to meet only 70 percent to 80 percent of the oil industry's needs, thus constraining the growth of oil production. The reported gain in output of equipment, if true, is not confirmed by the limited production sample of equipment published in Soviet handbooks (see table 1). For example, the 1976-80 production of turbodrills and drilling rigs was only about 9 percent and 9.5 percent, respectively, higher than in 1971-75.

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Moreover, the USSR is plagued with problems of quality in the manufacture of its petroleum equipment. Press reports are rife with complaints about the poor quality of domestic oil and gas field equipment, especially drill pipe, casing, drill bits, drilling rigs, and submersible pumps. Shortfalls--both qualitative and quantitative--in equipment supply continually threaten fulfillment of production goals in the oil industry. In December 1983 for example, the Supreme Soviet's Plan Preparatory

Table _

USSR: Production of Petroleum Equipment

Equipment	Unit of Measure	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Deep-well pumps	1,000 units	77.0	81.0	81.0	82.0	85.0	85.1	86.1	83.2	95.0	95.0	91.6	95.0	96.0
Turbodrills	sections	6,562	7,384	7,694	8,103	9,328	9,780	9,354	9,700	9,016	8,976	9,270	9,459	9,291
Drilling rigs for development and deep exploration drilling	complete units	480	497	512	516	483	544	511	503	505	473	521	541	558
Refinery equipment	1,000 tons	127	139	157	159	172	171	164	171	180	188	184	NA	NA
Refinery equipment	million rubles	91.6	NA	NA	NA	NA	123	151	170	183	195	201	209	210

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well logging. However, progress in exploration is impeded by technological limitations in several key areas. For example, Soviet technology in magnetometers and gravity meters lags considerably behind that available in the West. Efficient performance of regional surveys requires the highly sophisticated sensing technology embodied in these instruments, as well as advanced data-processing capability. Rather primitive seismic equipment forces the Soviets to rely on techniques which can identify large geologic structures but which lack the resolution to identify smaller, more subtle traps. These techniques also yield poor results below 3,000 meters, hampering deep exploration. The Soviets generally lack the computers and sophisticated software to process the seismic data into usable high-resolution form. Remote areas, such as East Siberia and the offshore arctic, will be difficult to explore without improved geophysical surveying equipment and technology. [redacted] 25X1

B. Drilling Equipment

Soviet drillers have received heavy criticism and much of the blame for the sharply declining rate of growth in Soviet oil production. The industry's major problem is the poor quality and inadequate quantity of drilling equipment--rigs, drill pipe, tool joints, bits, and blowout preventers--combined with poor execution in the field. Because of the emphasis on meeting high-volume drilling goals and the USSR's lack of high-quality drill pipe capable of meeting the stresses of rotary drilling, Soviet drillers rely principally on turbodrilling. Although

turbodrilling is a noteworthy achievement, it is less efficient than rotary drilling for the deeper deposits and high-stress conditions that the Soviets are increasingly encountering. 25X1

According to official Soviet statistics, the USSR produces about 500 to 600 oil and gas drilling rigs annually (see table 1). Most of these rigs are manufactured at two plants in the Volga-Urals region--the Uralmash Plant in Sverdlovsk and the Barrikady Plant in Volgograd. The average service life of a Soviet rig is about 6 years, compared with about 15 to 20 years for rigs built in the West. Productivity has risen during the past decade as improvements have been made in Soviet rig design, but there are chronic complaints that the mix of rigs is inadequate: especially lacking are compact portable rigs for use in northern climates. Rig shortages have been reported, particularly in West Siberia, where the planned doubling of drilling there between 1980 and 1985 will be difficult to achieve without a major increase in drilling productivity, a greater supply of high-quality rigs, and improved availability of skilled workers. 25X1

Soviet drill pipe can be used for drilling relatively shallow wells (less than 2,000 meters deep) with the turbodrill, because little torque is applied to the column of drill pipe. However, in the deeper wells where rotary drilling is used, the poor-quality steel used in Soviet drill pipe often fails. Problems related to the quality and quantity of drill pipe and casing produced in domestic plants are sporadically cited in the Soviet press. In 1980 a news account indicated that 4 to 6

percent of the casing delivered to well sites was unusable. Insufficient quantities of drill pipe and casing were listed as factors causing the underfulfillment of West Siberian drilling targets in 1979 and 1980. [redacted] 25X1

The quality and performance of drill bits produced in the USSR improved during the 1970s and early 1980s, but Soviet bits are only one-quarter to one-tenth as efficient as bits of comparable function made in the West. The Soviets reportedly produce over one-half million bits of all types annually. [redacted] 25X1

Widespread use of the turbodrill in the USSR has been effective in the shallow, hard-rock formations in the Volga-Urals basin and for directional drilling from the cluster-drilling pads in West Siberia. By eliminating torque on the drill string, turbodrilling permits the Soviets to sidestep many of the problems associated with the use of low-quality drill pipe and tool joints (which could not be used in rotary drilling), and it increases the initial rate of penetration and reduces the amount of time lost in breakdown. The turbodrill's much higher rate of bit rotation leads, however, to increased abrasion of cutting surfaces and often, in turn, to premature replacement of bits. Attempts are being made to improve the turbodrill by adding more sections to the hydraulic turbine (to maintain torque while reducing the turbine speed), increasing pump pressure, and installing better anti-friction bearings. At the present time the USSR produces more than 9,000 turobdrill sections annually. Such a production rate implies that most of these units wear out rapidly, generally lasting less than one year. [redacted] 25X1

C. Production Equipment

1. Artificial lift

As oil wells stop flowing because of low reservoir pressure or as water cuts (percentage of water in the oil-water mixture produced from an oil well) in the produced fluid exceed a certain threshold, artificial lift equipment--rod-and-beam (sucker-rod) pumps, submersible pumps, and gas-lift units--are installed to maintain or increase oil production. Rod-and-beam pumps are used for low-flow wells, and high-capacity electric, centrifugal submersible pumps are used to lift large volumes of fluid. Gas-lift is a process that artificially increases the flow of fluids from a well by continuous injection of gas into the wellbore at relatively high pressure. Essentially, gas lift is a low-maintenance alternative to high-capacity submersible pumps, although the initial equipment and installation costs are higher.

[redacted] 25X1

As of 1 January 1980, of the inventory of 82,500 producing oil wells, 86 percent were being produced by artificial lift--51,600 by rod-and-beam pumps, 17,200 by electric submersible pumps, and 2,300 by gas lift. During 1971-79, Soviet production of rod-and-beam pumps rose by nearly 50 percent, and in 1980 these pumps were used in 62 percent of all producing wells. The rod-and-beam pumps, which embody low technology, have the worst service record of all the artificial-lift equipment produced in the USSR. They have an average service life of only 90 days compared with 350 days for those produced in the United States. Breakage of pump rods, poor sleeve bearings, and sleeve

misalignments are the main causes of rod-pump malfunctions. [redacted] 25X1

The output of submersible pumps in the USSR trebled during 1971-79. As of 1980 about one-fifth of all producing wells in the USSR were on submersible pumps, and these wells accounted for about one-third of total oil output. The quality of the Soviet-made pumps, however, is far inferior to those manufactured in the United States and their capacity is inadequate for many of the high-yield wells in West Siberia. During the 1970's the USSR imported from the United States some 1,200 high capacity submersible pumps with an aggregate fluid-lift capacity of about 3 million b/d. Although Soviet plants are producing substantial numbers of submersible pumps, and are attempting to improve their capacity and quality the Soviet press continues to criticize the quality of these pumps. This suggests that the Soviets may at some point again turn to the West for high-quality, high-capacity submersible pumps. [redacted] 25X1

The USSR produces a small amount of gas-lift equipment. Because of the high frequency of repairs on pumping equipment, some Soviet petroleum officials have become more interested in the use of the gas-lift process for producing oil. In 1969, Western compressor-pressured gas-lift equipment was installed for the first time at the Pravdinsk oilfield in West Siberia. As a result of experience with this equipment, the Soviets installed their own compressorless gas lift equipment at the Uzen' field in Kazakhstan and at the supergiant Samotlor field in West Siberia, using high-pressure gas available at each of these oilfields. In 1980, less than 3 percent of the total producing wells in the

USSR were using the gas-lift process. [redacted] 25X1

The initial capital investment for most gas-lift systems is higher than that for pumping units because of the need for gas pipeline, infrastructural equipment, and--frequently--compressors. However, maintenance costs are much lower for gas-lift wells; wireline tools and special workover rigs permit rapid workover of wells with minimum downtime, resulting in the use of only one-tenth the number of personnel to maintain the wells.

2. High-pressure, High-temperature, Corrosion-resistant Equipment

As production of oil and gas from deep reservoirs (below 2,500 meter depths) increases, the Soviets are unable to produce the required high-pressure, corrosion-resistant downhole and surface equipment. The range of items needed for deep wells includes casing, liners, tubing, packers, valves, mandrels, pump rods, submersible pumps and cable, bottom-hole chokes, and safety valves. At the surface are needed Christmas trees, wellheads, and hangers for anchoring the casing. Special heat-and-corrosion-resistant metals, alloys, seals, threads and fittings are used to withstand the severe operating conditions encountered in sour-gas deposits at Orenburg; at the Astrakhan', Karachaganak, and Tenghiz fields in the Pre-Caspian Depression; and at the Central Asian fields. Only small trace amounts of hydrogen sulfide (H_2S) or carbon dioxide (CO_2) when combined with the salts in water cause stress-cracking of the metal used in oil and gas well equipment. Therefore, special corrosion resistant equipment must be ordered from the West. [redacted] 25X1

3. Enhanced Oil Recovery (EOR)

Enhanced oil recovery (EOR) refers to recovery of oil from a petroleum reservoir beyond that economically recoverable by conventional primary methods (using natural reservoir energy) and secondary methods (artificial maintenance of reservoir energy and artificial lift). EOR employs physical, chemical, or thermal means to alter the forces which hold the oil in place in the reservoir rock. [redacted] 25X1

The importance of increasing oil recovery from existing fields has been recognized in the USSR since the early 1960s, but it was not until 1976 that the EOR program was given priority. The optimism and confidence expressed for this program by high-level Soviet officials has not been realized. As of 1982 the commercial output of oil obtained by EOR techniques was only about 60,000 b/d, or about 0.5 percent of total oil production. [redacted] 25X1

The Soviets have experimented with EOR programs in many fields, emphasizing thermal and chemical applications. However, difficulties have been caused by limited domestic production capabilities. Soviet industry has not been able to build the steam generators needed for thermal recovery or to produce sufficient amounts of surfactants or polymers for chemical and polymer flood operations. In addition to the normal problems of duplicating laboratory results in any oilfield, management and financial problems have plagued the Soviet EOR program. Most notably, the Deputy Minister of the Petroleum Industry in charge

of enhanced recovery projects was fired in 1981 for falsifying data and gross waste of EOR materials. Since this scandal was made public, the Soviets have postponed several EOR projects, citing both management and technical difficulties, as well as high costs. [ ] 25X1

D. Offshore Technology

The USSR is looking to its offshore areas to provide future production of oil and, ultimately, natural gas. These areas are believed by geologists to have great oil and gas potential. To date, however, production of oil and gas from offshore deposits has had very little impact on national output. The technical requirements are high, and Soviet capabilities for offshore work lag much farther behind the state of the art than in any other phase of petroleum exploitation. Almost all of Soviet offshore production of oil and gas comes from shallow-water and near-shore deposits in the Caspian Sea. [ ] 25X1

The USSR is attempting to upgrade offshore capabilities through purchasing equipment and technology from the West, reproducing equipment of Western design, and strengthening domestic manufacturing capability. At this time their offshore activity is dependent on the West for the bulk of the modern drilling and producing equipment and technology employed. [ ] 25X1

E. Pipelines

In the USSR pipelines account for about 90 percent of crude oil and 10-15 percent of petroleum products transported. Most of the Soviet oil pipeline network is relatively new, having expanded from about 17,000 kilometers in 1960 to almost 73,000 kilometers by the end of 1982. Nearly 80 percent of the larger diameter--1,020 and 1,220 millimeter (mm)--oil pipeline network was laid between 1970 and 1982. 25X1

The Soviet oil pipeline industry is largely self-sufficient; there is no required equipment that cannot be produced from domestic sources. The Soviets do import, on a selective basis, pipelayers, bulldozers, surge control valves, and insulating materials to speed construction and to improve the operational capacity and service life of their pipelines. Soviet pipeline construction techniques and pipe manufacturing technology are inferior to those in the West, and, combined with poor quality pipe welding and insulation, these practices often lead to more-rapid-than-expected pipe deterioration. Corrosion takes a heavy toll on pipeline facilities. The Soviets are already having to replace sections of some relatively new pipelines. 25X1

With the emphasis on natural gas pipeline construction in recent years (the length of the gas transmission pipeline system was 144,000 kilometers at the end of 1982), the USSR has been heavily dependent on Western large-diameter linepipe, pipelayers, turbine-compressors, ball valves, and controls. To date the bulk of domestically produced large-diameter linepipe is unsuited for high-pressure natural gas transmission service, especially in the

arctic regions where the largest producing fields are located. Imported Western steel plate is now being manufactured into 1,420 mm diameter linepipe, but annual output of this pipe is less than one million tons. The domestic turbine-compressors and pipelayers produced thus far are too limited in capacity or inadequate in quality to perform efficiently on 1,420 mm pipelines. [redacted] 25X1

The Soviets, however, are currently attempting to improve the quality and capacity of their linepipe and major pipeline equipment. For example, a new, more powerful and stable pipelayer (TG-502), designed for laying 1,220 mm and 1,420 mm-diameter pipe, was put into series production in 1980, and some 400 to 500 units were to have been produced in 1983. The Soviets, moreover, appear to be successfully developing their own large-diameter pipe for high-pressure use, a multi-layered pipe manufactured in short sections. [redacted] 25X1

A priority program to develop high-capacity turbine-compressors for the gas pipeline network is underway. Serial production of a 16-MW unit (GTN-16) began in 1982 and prototypes of a 25-MW unit (GTN-25) were undergoing final testing in 1982-83 with some 14 units targeted for production in 1983. The Soviets claim that the GTN-25 turbine is on a par with Western industrial 25-MW turbines. This claim is, however, unsubstantiated as the new Soviet unit has not been adequately field tested. Given the USSR's poor track record in industrial gas-turbine design and production, it is unlikely that they could quickly achieve a high level of reliability and efficiency. [redacted] 25X1

F. Oil Refining

The USSR produces the bulk of its own refining equipment in numerous petroleum and chemical machinebuilding plants throughout the country. However, imports have served to supplement domestic supplies. East Germany has been supplying some standard 120,000 b/d-capacity pipe stills to increase capacity at existing refineries, and Czechoslovakia has delivered catalytic reforming and hydrogen-treating units since the mid-1970s to upgrade the quality of light products. During the past several years, Western firms have delivered several catalytic reformers to upgrade motor gasoline quality and calciners to produce high-quality petroleum coke. The only known hydrocracker in operation in the Soviet Union is a Western-built unit at the Ufa refinery. Soviet attempts to copy this unit and expand its capacity have not been successful. [redacted] 25X1

Planned expansion of secondary refinery capacity to reduce the yield of heavy products and raise the yield of high-quality light products is lagging badly. The program calls for installation of modern catalytic-cracking, hydrocracking, hydrodesulfurization, catalytic reforming, and hydrogen-treating processes. It is doubtful that the Soviets have the domestic manufacturing capacity to produce all of the units required, [redacted] 25X1

[redacted] 25X1

G. Gas Processing

Construction of gas-processing facilities has taken a growing share of total gas industry investment in the USSR since

the mid-1970s. The Soviets are able to provide nearly all of the equipment for these facilities in the West Siberian region, where low-sulfur gas is being produced in increasing volume. However, in the sour-gas deposits of Orenburg, Astrakhan', Tenghiz, and Central Asia, Western equipment and technology are required to process gas containing a high percentages of H_2S, and CO_2. As the Soviets prepare to exploit new sour-gas deposits such as Astrakhan' and others in the Pre-Caspian Depression, they are ordering Western production and processing equipment. [redacted] 25X1

IV. Recent Reliance on Western Equipment and Technology

The Soviet oil industry transformed itself from near total devastation during World War II into a large self-supporting industry capable of leading the world in the quantity of oil produced. Similarly, the remarkable expansion of the gas industry over a period of two decades brought it in 1983 to the status of being the world's leading natural gas producer. Both of these industries achieved this expansion with equipment and technology that generally suffer in comparison to those available in the West. Much of the Soviet technological problem stems from an inefficient and cumbersome economic system and inferior performance in metallurgy and metalworking. The failures of the system have hindered the production of high-quality equipment in the quantities needed and have interfered with the efficient use of advanced techniques and equipment. [redacted] 25X1

The Soviets have in the past compensated for equipment shortcomings or met needs for particularly difficult operations by importing from the West. During the 1970s the USSR ordered or

bought about $2 billion worth of Western oil equipment, which was only a small share of their total equipment needs. In the gas industry, much of the large-diameter pipe, compressors, and ball valves for expansion of the high-capacity domestic and export pipeline network was imported from Western countries. The value of imported Western equipment used on the gas pipeline system during the 1970s approximated $3 billion. These imports of Western equipment had an impact far out of proportion to their cost, however, because they were used on the Soviets' largest and most critical oil and gas projects. [redacted] 25X1

Soviet purchases of petroleum equipment and technology from the West during the 1970s included the following:

- o High-capacity electric centrifugal submersible pumps, gas-lift equipment, well-completion units, drill pipe, steam generators, seismic equipment, pipeline equipment (especially linepipe and compressors).
- o Plants to produce key equipment--the Dresser drill-bit plant at Kuybyshev and equipment for the offshore-rig assembly yard at Astrakhan'. [redacted] 25X1

A. Exploration Equipment

The USSR has made major purchases of collection and process-related geophysical equipment from Western firms. A significant number of the estimated 300 digital collection crews in the USSR have been supplied with Western equipment, including portable field recording units, remote processing minicomputer centers, and processors used in conjunction with the minicomputer systems. The USSR also is purchasing several a fully equipped

ships for offshore geophysical work and has had several of its own ships outfitted in the West for oil and gas exploration. [redacted] 25X1

Soviet well logging instruments lag Western equipment both in accuracy and efficiency, i.e., the number of sensors downhole at a given time. The USSR has purchased items of this equipment from Western firms, but not in amounts that significantly change the Soviet petroleum industry's overall capabilities. New exploratory and development wells measured with Western equipment may be completed much more efficiently and with greater accuracy than wells logged with domestic equipment. In most cases this would have a positive effect on oil and gas production. In order to improve logging operations appreciably, the USSR would have to buy enough Western hardware to equip at least 100 crews and also allow Western technicians on site to operate the equipment and train Soviet workers. Moreover, Soviet drilling-fluid technology would have to improve in order to reduce borehole contamination, which can block off many hidden oil and gas bearing zones. [redacted] 25X1

B. Drilling Equipment

Soviet press reports indicate that domestic plants continue to encounter problems in producing seamless tubular steel drill pipe, tubing, and casing--in the quantity and quality needed in oil and gas field operations. Purchase of high-quality drill pipe from Japanese and West European firms in recent years have allowed the Soviets to drill deep wells that now account for 5 to 10 percent of Soviet oil production and perhaps 20 percent of Soviet output of natural gas. The USSR recognizes the importance of high-quality drill pipe for its deep drilling program.

Discussions have been held with Western suppliers since the late 1970s for the purchase of a turn-key plant to manufacture high-quality drill pipe. [redacted] 25X1

During the 1970s the USSR purchased a number of drilling rigs from Western suppliers, including at least 15 portable rigs from Finland. The Western rotary rigs are of value in drilling operations where the Soviets have to drill deep under great pressure, a condition in which their turbodrill is inefficient. Although rigs imported from the West represent only a small share of total Soviet rig supplies for use on land, they comprise a much more significant share--40 percent--in the Soviets' emerging offshore drilling-rig park [redacted] 25X1

Although the USSR has not purchased a significant number of drill bits from the West, Soviet concern about drill-bit quality was demonstrated in the purchase of a turn-key drill-bit plant from a Western firm in 1978. This plant, located at Kuybyshev, is designed to produce 100,000 bits annually, 86,000 of which will be tungsten-carbide-insert, sealed-journal-bearing bits. These bits should operate for long periods at the high rotational speed of Soviet turbodrills, and each one should replace 2 to 4 bits produced at other Soviet bit plants. The new bits should also reduce Soviet downtime for bit replacement, thereby increasing rig productivity and reducing the rates of necessary expansion of the rig park. The Western-supplied plant reportedly is producing drill bits, but we believe that the Soviets have not achieved the planned rate of production or the desired bit quality. [redacted] 25X1

C. Production Equipment

Approximately 1,200 high-capacity electric centrifugal submersible pumps were purchased from US firms during the 1970s. These pumps had a total capacity to lift some 3 million b/d of fluid. Assuming that most of these pumps were used in wells where the water cut was about 50 percent and allowing for downtime for servicing and repair, their use could yield a maximum output of about 1.2 million b/d of oil. Under the conditions prevalent in Soviet oilfields, it is likely that the yield would be lower. [redacted] 25X1

In 1969, Western compressor-pressured gas-lift equipment was installed for the first time in the USSR at the Pravdinsk oilfield in West Siberia. By the early-to-mid-1970s this equipment may have accounted for a 20-percent increase in annual oil output at the Pravdinsk field, as well as a 10-percent rise in the oil recovery rate. [redacted] 25X1

In 1978 the Soviets undertook to expand gas-lift operations at Samotlor, and contracted with a Western firm to install compressor-type gas-lift equipment--gas compressors, manifolds, valves, controls--in 1,800 wells; similar equipment was purchased for 600 wells at the Fedorovo field in West Siberia. Completion of these projects was originally planned for 1985, but delayed for one or two years because of installation problems. In the interim, the Soviets have admitted they are trying to copy the Western gas-lift valves. [redacted] 25X1

During the past six years the USSR has entered into negotiations and has signed contracts with a number of Western

firms for the supply of equipment, chemicals, and plants to produce carbon dioxide and surfactants for enhanced oil recovery. A one-million-ton-per-year carbon-dioxide liquefaction plant was built near Tol'yatti for a miscible flood project at the supergiant Romashkino oilfield, and a second plant with a capacity of 400,000 tons per year was to have been installed in Kemerovo in West Siberia. [redacted] 25X1

The USSR has purchased high-capacity steam generators in the West for use in thermal EOR projects. There are indications that the Soviet oil industry has experienced problems in assimilating the Western equipment and technology. In the future, the Soviets may seek to obtain turn-key packages, rather than attempting to integrate individual items of equipment. [redacted] 25X1

D. Offshore Equipment and Technology

Most of the modern equipment and technology employed in Soviet offshore oil and gas exploration and production has been either purchased from the West or reproduced from technology supplied by Western firms. The Soviets have built five jack-up rigs copied from a Western-built unit imported in 1967. Their first semi-submersible rig was built in Finland. It was completed in 1980 and placed in operation in the Caspian Sea early in 1982. Three more copies of this semi-submersible rig have been built at the Western-equipped assembly yard at Astrakhan' and are now operating in the Caspian Sea. Finland has recently completed the delivery of three drillships to the USSR; two of these ships have conducted exploratory work in the Barents Sea and the third has operated southwest of Sakhalin. [redacted] 25X1

In addition to purchasing offshore equipment and technology, the USSR is conducting a cooperative venture with several Japanese firms to explore the offshore area around Sakhalin. At least two oil and gas fields have been discovered, but commercial production will not begin before the late 1980s. The USSR also is a partner in a consortium (Petrobaltic) with Poland and East Germany to explore for oil and gas deposits in the Baltic Sea. The consortium is using a jack-up rig and drilling equipment supplied by Western firms. [redacted] 25X1

E. Pipeline Construction and Equipment

Since the early 1960s imported large-diameter linepipe has played a key role in Soviet construction of gas, and some oil, pipelines. During the 1960s the USSR imported about 2.8 million tons of pipe, almost all 1,020 to 1,220 mm in diameter. Imports accounted for about 40 percent of total Soviet pipe supply during this period. During the 1970s the Soviets began to expand their transcontinental gas pipeline network with 1,420 mm pipelines, but they were unable to produce high-quality steel plate for the manufacture of high-pressure linepipe. Thus, they were dependent on the West for 1,420-mm pipe, as for well as steel plate for a small amount of domestic 1,420-mm pipe production. During 1971-80, total Soviet pipe imports amounted to an estimated 15 million tons, of which about 10 million tons were 1,420 mm in diameter.

[redacted] 25X1

As the Soviets expanded the large-diameter gas pipeline network, domestic capacity to produce suitable turbine-compressors was inadequate to meet demands. As a result, the

USSR was forced to rely on Western firms to supply gas turbines and spare parts for a substantial number of compressor stations. During the 1970s, the West supplied approximately 300 gas turbines with capacities from 10 MW to 25 MW. The total installed capacity of Western turbine-compressor units accounts for about 15 percent of total Soviet operating compressor capacity in the early 1980s. [redacted] 25X1

V. The Role of Technology Transfer During 1984-90

The Soviet oil and gas industries have raised their level of technology and equipment during the past few years, and steady improvements are likely over the remainder of the decade. However, as the USSR seeks to discover and develop new oil and gas deposits onshore and offshore, it will encounter deeper and more complex geologic conditions--often in highly corrosive environments under high pressure and temperature. These conditions will pose a substantial challenge to the equipment manufacturing sector, which thus far has been unable to meet domestic demand for high-quality petroleum drilling and producing equipment or advanced state-of-the-art production techniques and systems. [redacted] 25X1

Moscow will continue into the 1990s its purchasing of Western oil and gas technology and know-how, especially for finding and developing deep, less-accessible onshore and offshore reserves. We believe future purchases will cluster into 10 broad categories:

- Oil and gas exploration equipment
- Deep-well drilling equipment and technology

- Fluid-lift and oil-treatment equipment
- Offshore drilling and production platforms and related systems
- Computers and automated control technology and equipment
- Specialized corrosion-resistant drilling and production equipment for high-pressure, high-temperature service
- Enhanced-oil-recovery technology and equipment
- Gas pipeline equipment
- Secondary oil-refining equipment
- Gas-processing equipment [redacted] 25X1

The Soviets probably will continue to pursue methods other than outright purchase for acquiring Western technology. They regularly collect information on Western-developed technology and equipment [redacted] They also use joint development projects similar to their Sakhalin offshore exploration and development agreement with Japan to obtain Western know-how and equipment--and these projects have the added benefit of not requiring large upfront payments of hard currency. Moscow is currently pursuing a joint oil and gas exploration and development scheme for the Barents Sea with firms in several Western countries. For these joint projects to bear fruit, however, the Soviets will have to overcome their past reluctance to grant foreign firms access to geologic and field data. [redacted] 25X1 25X1

The effect on oil and gas output of foreign purchases and improvements in domestic technology will ultimately depend on the ability of the Soviets to assimilate and apply them on a timely

basis. The track record, however, as elsewhere in Soviet civilian industries, has been poor. Soviet research institutes and key industrial ministries frequently have acquired state-of-the-art knowledge and have closely studied and tried to copy Western techniques and equipment. But the timely application of this knowledge and equipment in large-scale field projects has been difficult, primarily because of systemic constraints--a dysfunctional incentive and reward system and a reluctance on the part of managers to take necessary risks. The Soviets recognize these problems and have made some preliminary attempts at solving them, but we do not expect the kind of fundamental changes that would allow the effective assimilation of new and improved technologies on a timely basis or on a scale that would dramatically raise efficiency and productivity the oil and gas industries. [redacted] 25X1

For at least the remainder of the 1980s, the bulk of Soviet oil and gas production will continue to come from large, relatively shallow deposits of petroleum that pose few serious technical obstacles to exploitation. An increasing share of output will, however, originate from deeper deposits in more complex geologic environments, where--in the absence of unexpected progress in Soviet manufacturing capabilities--Western equipment will be needed. [redacted] 25X1

The denial of Western equipment would require the Soviets to allocate more investment to industries manufacturing oil and gas equipment and would make energy production somewhat more difficult and costly. This could produce ripple effects in the

economy, but these almost surely would be minor and, in any event, difficult to quantify. The effort that was rallied to complete the laying of the gas export pipeline ahead of schedule is only one indication of Soviet willingness to devote resources to what Moscow considers to be high-priority projects. Moreover, the capability of not only Soviet industry but also other potential suppliers of oil and gas equipment outside the circle of traditional Western suppliers is improving rapidly. [redacted] 25X1